are observed in solutions of different concentration are discussed at length. The second section is on the connection between the optical rotation and the chemical constitution of carbon compounds, in which the original observations of Pasteur and the theory of the asymmetric carbon atom of Van 't Hoff and Le Bel are fully described, a subject on which a vast amount of work has been recently done. The third section is on the relation between the magnitude of the rotation and chemical constitution, and accounts are given of the rotations of isomeric bodies, of bodies belonging to homologous series and the effect of multiple bonding of carbon atoms.

The last chapter of the book is by Dr. O. Schönrock, on the relation between the electromagnetic rotation of solid and liquid bodies and their chemical composition; it extends over seventy-three pages, and was finished in 1898. The observation made by Faraday in 1846, that the plane of polarisation is rotated when the beam is passed through a transparent substance placed in a powerful magnetic field has led to valuable researches, principally by Perkin, on the rotation produced by various chemical compounds. The mode of calculating the molecular magnetic rotation and the influence of solvents are first mentioned, and then the effects produced by inorganic acids and salts and the atomic rotation of the elements. The periodic character of the magnetic rotation of some of the metals is pointed out. The next part deals with fatty substances, and numerous tables are given showing the variations which occur with change of composition, and the influence of the various radicals is calculated.

The volume concludes with an index of twenty-three pages, divided into sections corresponding to the nine chapters of the book; by this means the physical characteristics of the chemical substances can at once be found.

The whole volume has evidently been compiled with great care, and brings together a large amount of valuable information distributed in the *Transactions* of societies and other periodicals, thus saving the investigator desiring to make use of these researches, a great deal of time and labour in referring to the original papers. It will also enable the chemist to appreciate the great assistance that he may obtain from the study of the physical properties of compounds in his endeavours to ascertain their constitution and their relation to one another.

H. M.

THE SCIENTIFIC STUDY OF VACCINATION.

Vaccination: its Natural Historv and Pathology. By Dr. S. M. Copeman. Pp. x + 257. (London: Macmillan and Co., Ltd., 1899.)

THE Milroy Lectures on the Natural History and Pathology of Vaccination, delivered last year before the Royal College of Physicians, are now at an opportune moment given to the public. The Vaccination Act of 1898 has practically abolished compulsory vaccination. On the other hand, it aims at improving the administration of vaccination and at removing all objections that can, with the least show of reason, be brought against it. Without in any way admitting the existence of adequate grounds for giving up compulsory vaccination, which we look upon as a grave national misfortune, it must be acknowledged that opposition to the compulsory law has been in a measure based upon administrative defects. To do away with that opposition the first thing wanted is much greater care in the methods employed. Illness and death from vaccination ought to be as rare here as in Germany. To attain this end two things mainly are wanted: a scientific study of the quality of the lymph used, and a rigid and minute adherence to antiseptic principles on the part of the vaccinator. A lymph which is pure, in a bacteriological sense, and aseptic conditions from first to last, as regards the wounds made, ought to do away with all vacccination accidents.

Dr. Copeman's book deals mainly with the first of these subjects. In the early chapters he reviews the history of vaccination, of various lymph stocks, and of the relationship between variola and vaccinia. He relates the experiments made from 1801 to the present time, to prove experimentally the truth of Jenner's original thesis that vaccinia is small-pox of the cow. The experiments detailed are those of Gassner (1801), Viborg (1807), Thiele (1836 and 1838), Ceely (1839), Badcock (1840), Adams and Putnam (1852), Simpson (1885 and 1892), Fischer (1886 and 1890), King (1889), Hime (1892), Haccius and Eternod (1893), and Klein (1892). All these observers succeeded in inoculating human small-pox into a cow or calf, and in developing cow-pox as the result. Dr. Copeman's own experiments date from 1892. He was successful in one out of four attempts. The transformation of small-pox into cow-pox seemed in most of the successful experiments to require a series of inoculations from one cow or calf to another, and not to be an immediate result on first inoculating the contagium into its new conditions. It was probably from not knowing this fact that Chauveau, in 1865, and Martin, of Boston, in 1860, reproduced human small-pox by vaccinating from cows who had been the subjects of variolous inoculation. The variolous poison had, in these cases, not had the time required for its transformation into vaccinia. There remains, however, much still to learn as to the conditions under which the change from variola to vaccinia is accomplished.

With regard to the bacteriology of vaccine lymph, a subject on which much laborious investigation has been expended, Dr. Copeman comes to the conclusion that from lymph taken from matured vesicles "inoculation of plates or tubes of nutrient material usually result in abundant growths of micro-organisms." Dr. Copeman succeeded, however, in growing the small-pox contagion as a pure culture, by using hen's eggs as the culture medium. "For the purpose of such inoculations I employed variolous crusts. . . . These crusts were rubbed up in a small glass mortar with a minimal quantity of water . . . and the inoculation was carried out. Finally the small hole in the egg was closed up." The eggs so inoculated were kept in the incubator for a month, and calves were then inoculated with the egg culture, and after being passed through a series of calves the resulting lymph was successfully used for the vaccination of children. Drs. Copeman and Blaxall have since obtained pure cultures of "the same organism on the surface of agar plates, and this not only when vaccine

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lymph, both of human and bovine origin, was employed, but from variolous lymph as well." From these plates sub-cultures were obtained, and from the third and fourth generation typical vaccinia was induced both in calves and in children.

Monkeys have been of considerable assistance to Dr. Copeman in his investigations upon lymph. He began by proving experimentally that they are susceptible both to vaccination and to variolation, and he found that in them vaccinia protected from small-pox, and *vice versa*. "In no instance had the experiment a fatal termination," nor does it appear from the report that even variolation caused serious illness; it was "inoculated" rather than "natural" small-pox. Dr. Copeman adds:

> "In discussing the origin of the various lymph stocks at present in use, Messrs. Collins and Picton in their minority report make a point of the impossibility of employing at the present day what used to be known as the 'variolous test' as a proof of the efficacy or the reverse of any particular strain of lymph. In view, however, of my experiments with monkeys this criticism . . . falls to the ground; since if it is desired to apply the variolous test to any given lymph stock, all that is necessary is to vaccinate a monkey with a sample of the lymph in question, and subsequently to inoculate the animal with potent small-pox lymph after the lapse of such period from the first operation as may be thought desirable."

Dr. Copeman's researches upon the effect of glycerine in purifying and preserving vaccine lymph, date from 1891. Previous to this he had seen reason to think that the exuberant growth of what may be called extraneous organisms, might tend to check the development of the more important organism for which he was searching. He therefore set himself to find an agent which would check the growth of these extraneous or useless micro-organisms in lymph.

The use of glycerine as a diluent or preservative of lymph had long been known. What was not known was that by an intimate admixture of perfectly pure glycerine with lymph, and by storing the mixture for a considerable time under conditions which prevent the access of air and light, the foreign organisms in the lymph are gradually destroyed or so checked in their growth that they cease to multiply and come to an end. The proportion of glycerine required for this inhibitory influence is a large one—30 per cent., 40 per cent., or 50 per cent. for the different organisms. Dr. Copeman details experiments made by himself and Dr. Blaxall with lymph to which had been added, a month before using it, large quantities of virulent tubercle bacilli. No growth of the tubercle bacillus could be obtained, nor was any effect produced by repeated injections of this lymph into guinea-pigs, while from the same supply of tubercle culture material, not treated with glycerine, tuberculosis was in due course developed, at first locally and then generalised.

It must be borne in mind that an essential part of the process Dr. Copeman recommends is the length of time during which the organisms in the lymph are exposed to the influence of chemically pure glycerine, unaided by the vitalising influences of light and air.

Dr. Copeman gives photographs of a series of sub-cultures on nutrient agar-agar after twenty-four hours, then after one, two, three, four and six weeks respectively. The extraneous organisms progressively diminished till at the end of four weeks there were none, and after six weeks there were also none.

It is natural to ask if glycerine can in time, and under favouring conditions, entirely inhibit the growth of extraneous organisms, will not the essential vaccine organism presently share the same fate? Is glycerinated calf lymph sure to retain its activity for a sufficient length of time for all practical purposes? These questions scarcely admit at present of an absolute answer. Dr. Copeman believes the lymph from different calves varies very much in potency. He quotes facts which go to show that there is no reason to distrust the lymph treated as he recommends while stored in bulk.

> "A lymph which was collected and glycerinated on July 13, 1897, has since been used at intervals of from twenty-four to thirty-two weeks after glycerination, for the vaccination of children. During this period sixty-one children have been vaccinated with this lymph in five places each, with a mean insertion success of 98 per cent."

It must, however, be borne in mind that for the children thus vaccinated the lymph had not been kept in capillary tubes. It is necessary to wait for further experience before it can be taken as proved that glycerinated lymph can be kept in an active condition for any considerable time in such tubes. It would be interesting to know if lymph can be stored and distributed in fairly large bulk in such a way as to be available when wanted, even where, as on board ship, otherwise perfect conditions as to temperature, exclusion of light and air can be secured. A method by which enough perfectly pure lymph to vaccinate, say, a thousand people, in one series, could be carried through the tropics would be of great value, and there seems some ground for doubting if glycerinated calf lymph in capillary tubes would under such conditions be absolutely trustworthy. It would have for the round voyage to retain its potency for at least from four to six months.

Dr. Copeman's contribution to the study of the bacteriology of vaccination is of high value and interest.

A MODERN TYCHO.

Siddhánta-Darpana; a Treatise on Astronomy. By Mahámahopádhyáya Sámanta Sri Chandraṣékhara Sim̱ha. Edited with an introduction by Jogés Chandra Ráy, M.A., Professor of Physical Science, Cuttack College, Calcutta, 1897.

Any one who reads the very interesting introduction of sixty-one pages that Prof. Ráy has attached to this Sanscrit work will regret very much his inability to fathom the work that follows. For therein is contained the results of the patient and industrious inquiry of one who, unaided by the accumulated knowledge of Western astronomers, resolutely set himself to solve the problem of celestial mechanics by the aid of such instruments as he could fashion himself, and where the time-honoured clepsydra supplied the place of the sidereal clock. The only assistance he seems to have had were the similar rough observations of Bháskara (born 1114) and some still older observers. Prof. Ráy compares the author very

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